GOVERNMENT OF IRAQ

Iraq. DEVELOPMENT BOARD
AND MINISTRY OF DEVELOPMENT

MAJOR IRRIGATION PROJECTS

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

1956

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Introduction

God endowed Iraq with abundant wealth which was and still is a source of welfare and prosperity. This wealth is represented by the water flowing in the valleys of the Tigris and Euphrates rivers, which increases the fertility of the soil, the volume of crops and enriches the economy of the country. But the benifits which we obtain from these water - flows could be greatly increased if flood control of both rivers is organised on correct and technical lines as the devastating floods which took place in the past caused great damages to the country. They destroyed farms and villages and inundated the crops and dispered the inhabitants of the flood - stricken areas. These catastrophs recurred. This recurrence stimulated the authorities to take much interest in controlling the destructive floods and making use of the excess waters in a manner which develops happiness and prosperity to the country.

The area of cultivable lands in Iraq is estimated at 22 million meshara or (62,500 square kilometers of 15 million acres). The area cultivated is estimated at 13 million mesharas; this cultivation, however, is based on fallow farming system. This means that the actual area actually cultivated every year is estimated at 6.5 million mesharas, which is equivalent to one fourth of the arable lands. When the vast irrigation projects undertaken by the Development Board, in Dokan & Derbendi Khan, are complete, the 13 million mesharas of cultivabete, areas will all be put under permanent cultivation instead of fallow farming.

Two large projects of those undertaken by the Development Board for the control of flood waters have been completed. These are the Tharthar and Habbaniyeh and by their completion full control of the Tigris and Euphrates have been maintained. When the other irrigation projects of the Development Board will be completed, Iraq will make available sufficient quantities of waters which may be used for irrigation instead of being wasted into the Arabian Gulf. Such use will increase the wealth and crops of the country and improve its ecnomy.

Water Control Projects

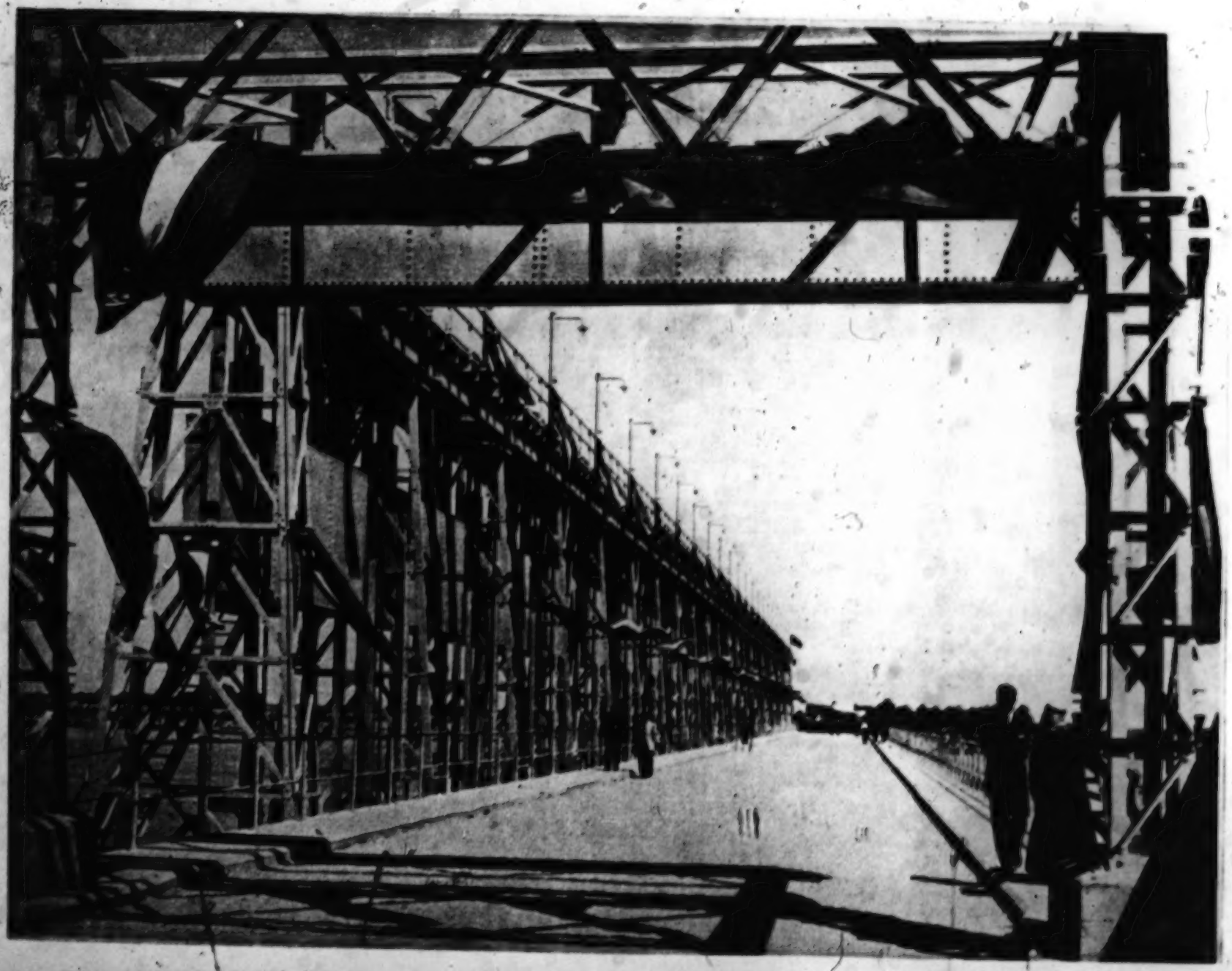
HABBANIYEH PROJECT:

This is considered one of the important projects constructed to control the water of the Euphrates River. The farms and towns lying along the river were saved by this project from the calamities brought by flood which also entails damages and losses every year. The volume of water flowing in the river during flood season is very big and there is no question of controlling these waters at the upper parts of the river before the flows arrive at the southern river basin where the capacity of the river stream is not sufficient, causing the water to overflow on both banks and cause severe damages and grave losses.

Several attempts to avoid the damages of floods and implement the plans and means of water control in the Euphrates were made. The Ottoman Government entrusted Sir William Wilcox with the task of studying the problem. As a result of his studies & investigations Sir William Willcox proposed to the Government to make use of the Habbaniyeh Depression for the storage of excess water by means of a channel connecting the river to the Habbaniyeh Lake. Excavations began in 1913 but the break - out of World War I caused the work to stop until 1932 when some amendments were made on the original project of which a third channel connecting the Lake to the river for returning the water back to the latter was introduced.

The project was brought to life again in 1939 but it lived only very shortly when

Ramadi Barrage



HABBANIYAH PROJECT

GENERAL MAP

SCALE

EUPHRATES RIVER

Dhiban Outfall Canal

Dhiban Outfall Regulator

MUSHAID DYKE

RAMADI BARRAGE

RAMADI

HABBANIYAH LAKE

Warrar Canal

Warrar Regulator

Majarra Regulator

Majarra Outfall Canal

Max. Water Level

Ramadi Barrage and Warrar Regulator

World War II broke-out and halted the works except for the excavation of the Majerah Escape and the construction of the relative regulator which were completed in 1941. It was decided in the light of the high floods of 1940 and 1943 to re-excavate the inlet channel at the Warrar location. The discharge capacity of the regulator was also increased to 2,800 cumecs. The amendments in the scheme also covered the site of the outlet channel and subsequently the site of the Dhibban Channel and Regulator was chosen somewhere behind the Habbanyeh Army Camp.

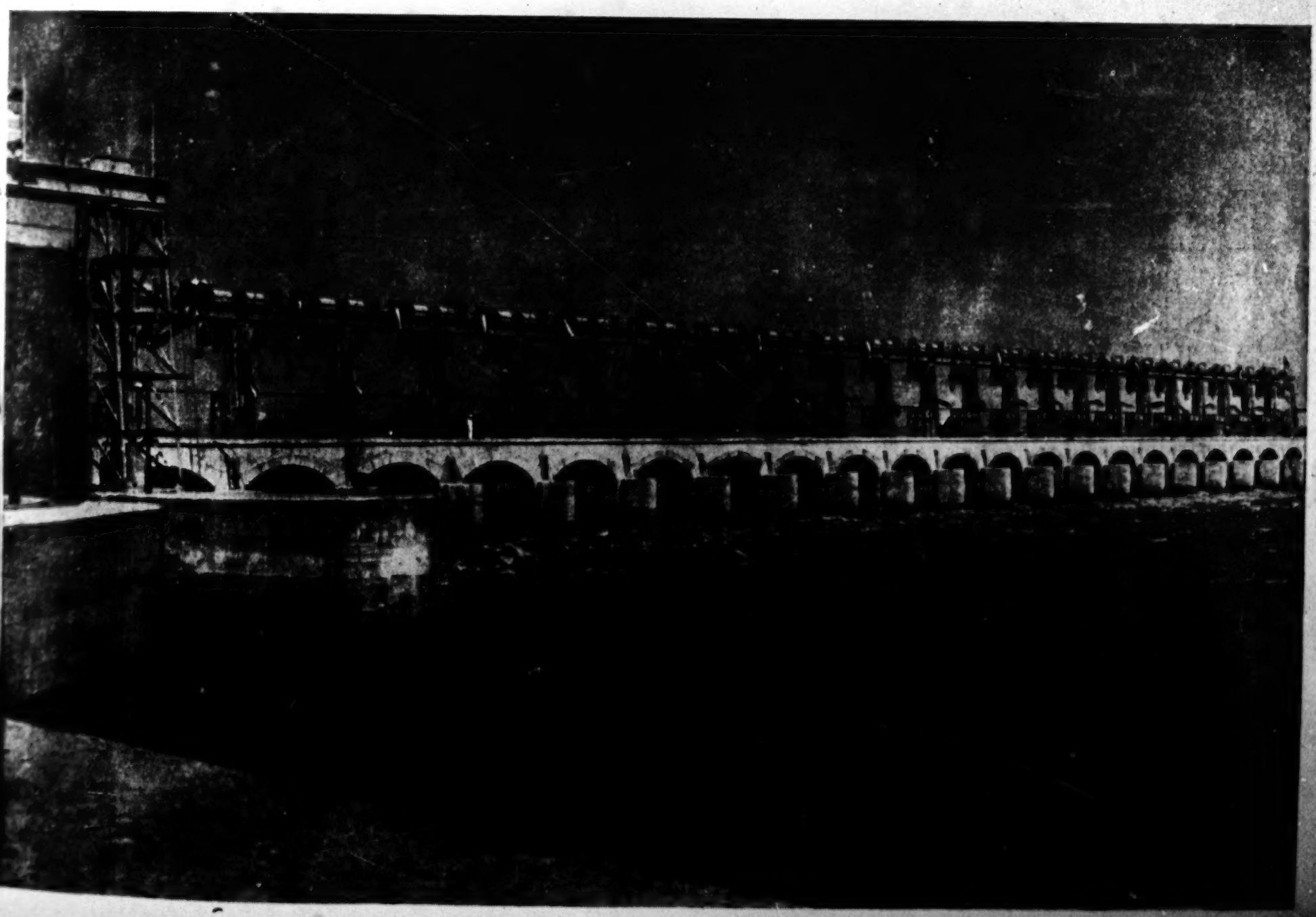
Eversince it was established the Development Board undertook the Habbaniyeh Project. It reconsidered the storage capacity of the Habbaniyeh Lake, the discharge of the Majarrah Regulator and the heightening of the Habbaniyeh Lake bunds with a view to raising the water level from 49.5 meters up to 51 meters thus increasing the capacity of the Lake to about 3.2 milliard cubic meters. The construction of a barrage across the Euphrates upstream Ramadi for the control of the river water, and for raising and diverting the water to the Habbaniyeh Lake through the Warrar Regulator & Channel was also considered. This will limit the water discharge down-stream the barrage to 2,500 cumecs. This quantity of water can flow without affecting the river course, threatening the bunds on the river banks downstream the

Ramadi Barrage or breaking through the bunds elsewere. The Ramadi Barrage is consisted of 24 vents each 6 meters in width with side pavements for pedestrians each 1.5 meters in width. The length of the barrage is 209 meters; it includes a navigation lock and a fishladder. The iron sluice gates are operated by electric power or by manual power should there be a power breakdown. The firm of Societe Annonyme Hersent of France carried out the work on the main barrage across the Euphrates at Ramadi for a cost of ID. 1,395,413/-; the work started on May 13, 1952. The firm of Ransome & Rapier supplied the iron gates in accordance with a contract concluded between them and S. A., Hersent: The cost of the gates amounting to ID. 211,550/- was charged to the original contract value.

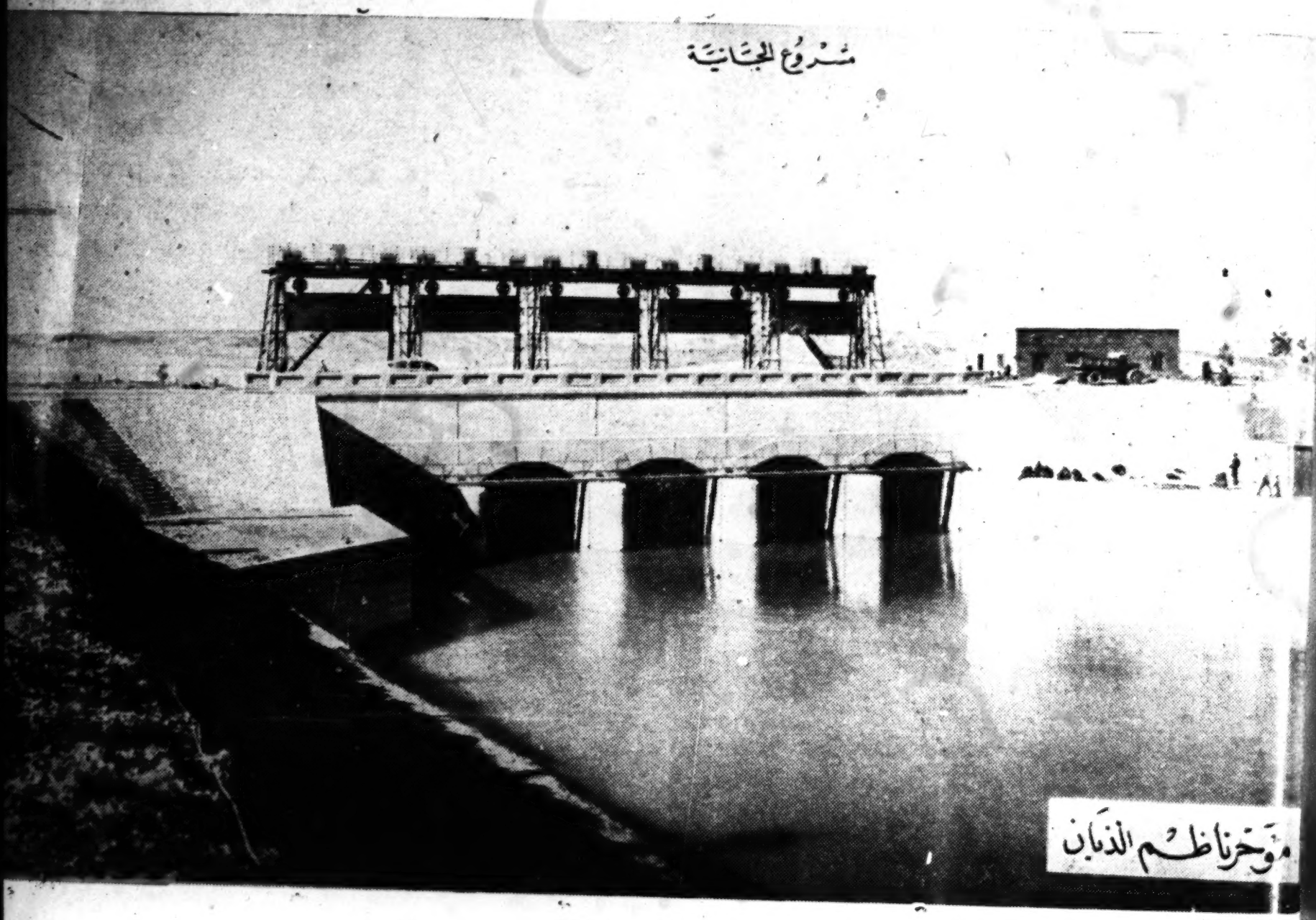
In addition to water control the Habbaniyeh Lake serves another purpose; it allows for the storage of 3.2 milliard cubic meters of water for feeding the river in the drought season. This storage will cause an increase of agricultural produce in the Euphrates River basin since new arable lands will be reclaimed. It will also assist the supply of sufficient water to lands presently under cultivation.

On April 5, 1956, the Iraqi Government officially celebrated the opening of the Habbaniyeh Project. All the works were

Ramadi Barrage



completed and the project was ready for operation. His Majesty King Faisal II patronised the inauguration ceremony. Several delegations from Arab & friendly countries attended and the day was a memorable event which Iraq boasts. The project was a gigantic development step towards the country's progress.



Dhibban Regulator

THARTHAR PROJECT:

This project which was recently completed aims at the reduction of flood flows on the Tigris River, and the supply of water to the Ishaqi Project. It consists of a barrage across the Tigris, opposite Samarra City, to raise and divert the water to the Wadi Tharthar Depression, and of protective bunds constructed over a length of 65 Km. for passing the excess flows of Water to the depression. The water level will be raised at the Barrage from 63 m. up to 69 metres. This elevation will help to divert into the depression up to 9.000 cumecs of the water discharge of the Tigris during the flood season.

The Tharthar Project is divided into two main parts:

Part 1 : This consists of earth work for the construction of the bunds and the excavation of the channel. The tenders for this work ware called under the Tharthar Project: -

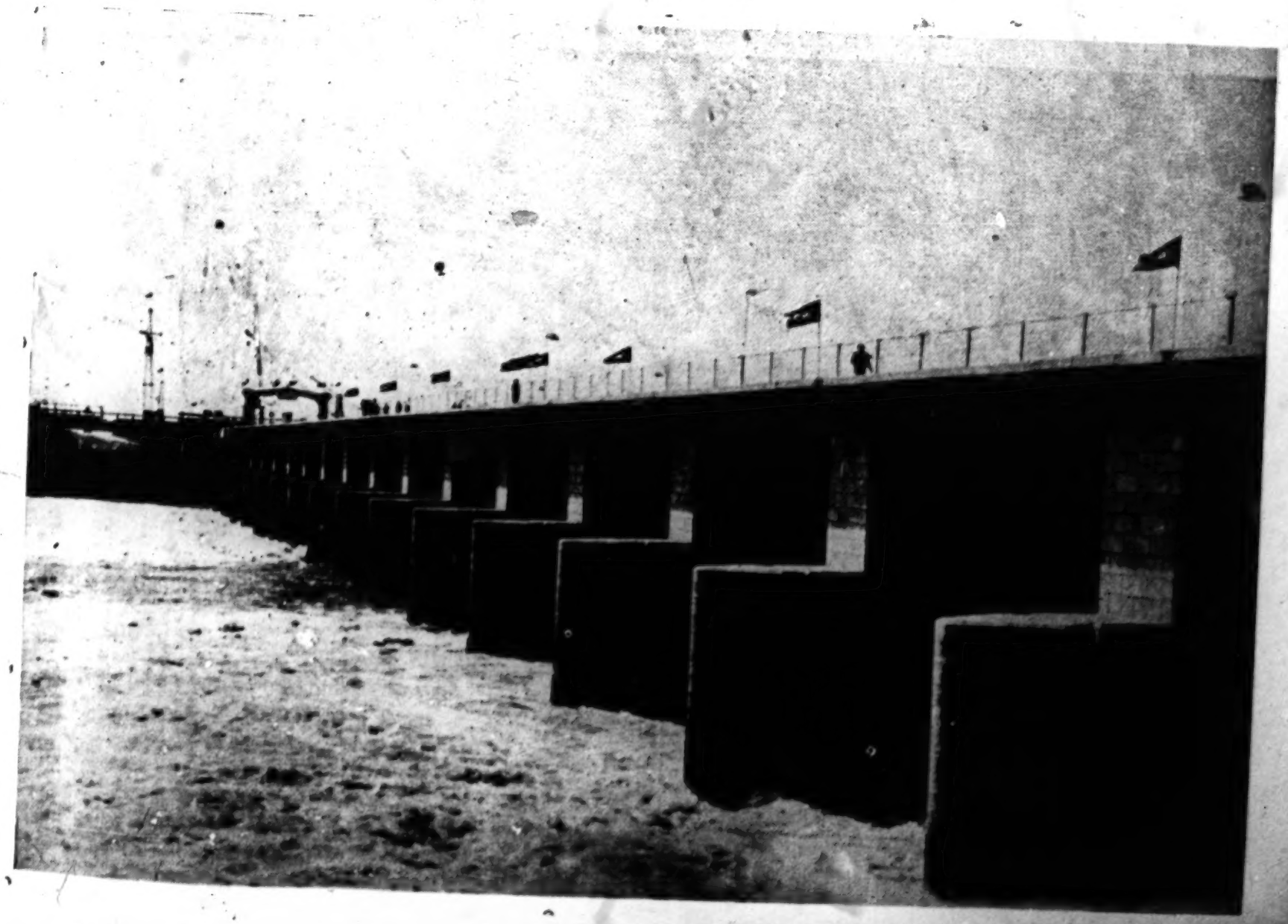
Contract No. 1 which was awarded on December 1951 to Balfour, Beatty & Co. at a cost of ID. 5,962,234. Work started on January, 1952, and in view of the expansion - of the project its ultimate in

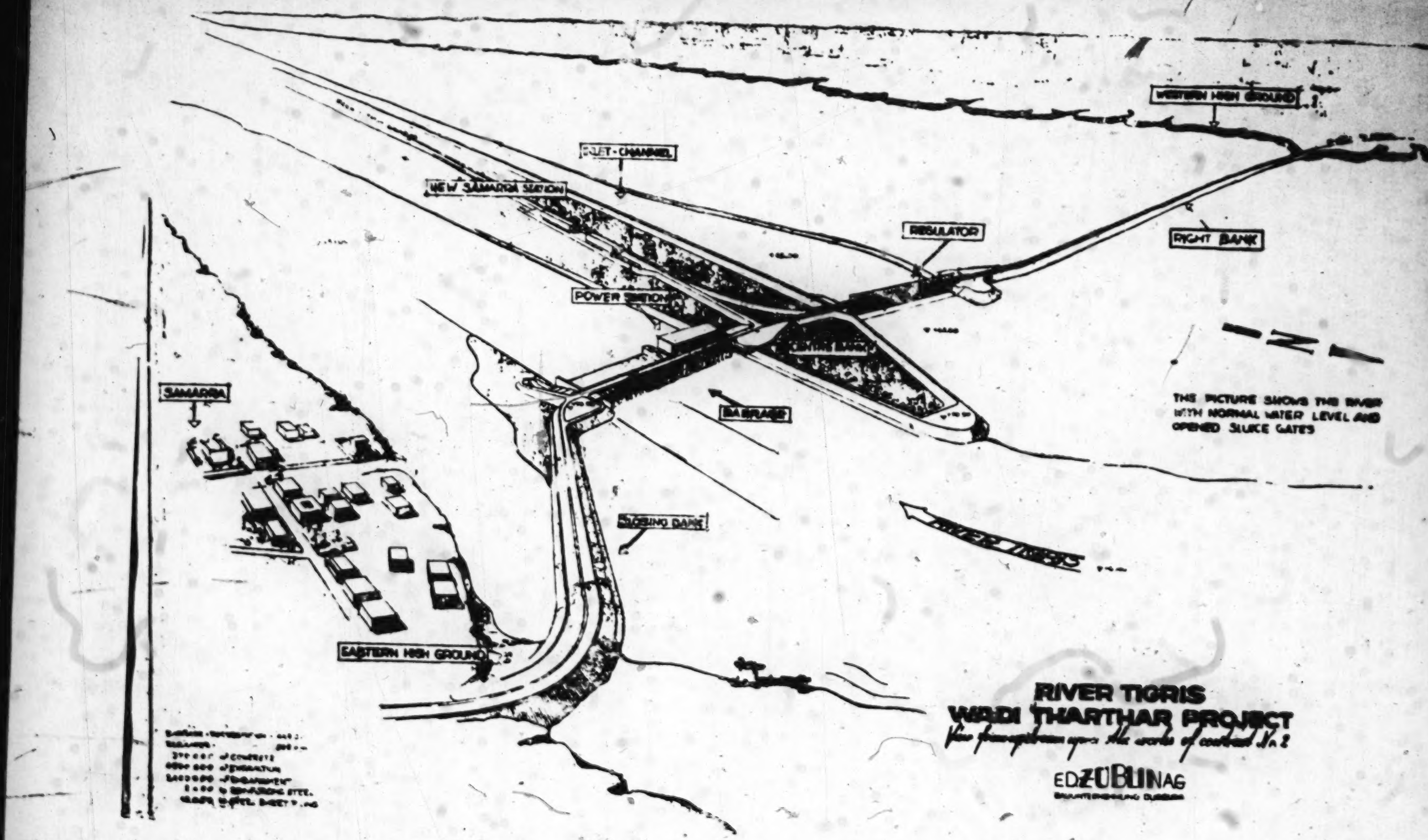
this job amounts to 35 million cubic methes and about 13 million cu. m. of earth filling. Camps for the work, including houses and offices for the Resident Engineer and his staff and houses and offices for the Contracting firm have been errcted. A laboratory for soil analysis was erected for analysing the soil suitable for the construction of the bunds to prevent water seepage. The earth work was completed in 1956.

Part II : This includes the head installation, and the relative tenders were invited under - the Tharthar Project Contract No. 2, was awarded on 23/2/1953 to the German Firm, Zublin, at a cost of ID. 4,948,398. But in view of the flood of 1954, this cost was ultimately increased to ID. 9,000,000/-. The contractor abided himself to complete the work by March 1956, and ensure the diversion of the flood waters of that year to the Tharthar Depression, and, in fact, the flood waters of this year were actually diverted.

The head installation covered by this contract includes a main barrage across the Tigris to be built on a dry bed opposite Samarra City. The water of the Tigris River was thereafter diverted after blocking the present river bed by means of an earth dam erected at the site of the present bridge. The barrage consists of 17 vents, each 12 meters wide equipped with sluice - gates of the Stoney Gate type, operated by electric power; They may also be operated by hand should there be a power break - down. The barrage is also used as a bridge to Samarra City instead of the present bridge. Along with and parallel to Samarra Barrage, the Tharthar Regulator was constructed. This consists of 36 vents, each 12 meter wide equipped with sluice -gates capable of passing 9,000 cumecs of flood water to the Tharthar

Samarah Barrage





RIVER TIGRIS
WADI THARTHAR PROJECT

View from upstream upon the works of contract No. 2

EDIZ ÜBÜNAG

مشروع
وادي الثرثار
WADI THRTHAR PROJECT

Scale .. المقياس

SAMARRA BARRAGE سد سامراء
INLET REGULATOR ناظم المدخل
سامراء SAMARRA
SHARI LAKE
نهر دجلة TIGRIS RIVER
ALGHAM RIVER
وادي الثرثار WADI THRTHAR
THRTHAR INLET CHANNEL
بيجي BAIJI
سكة Sikka
Rail Road
شهربان SHAHRABAN
دلتاوة DHLUIYA
TIGRIS RIVER
بعقوبة BAQUBA
DIYALA RIVER
Approximate 60 metre Contour
R.BAHADI BARRAGE
WARRAR INLET REGULATOR
Road to Shom
HABBANYA LAKE
بحيرة الحبانية
FALLUJAH
OUTLET CHANNEL
CAR ROAD طريق سيارات
الكاظمية KADHIMAIN
بغداد BAGHDAD
EUPHRATES RIVER
MAJARA REGULATOR
MAJARA OUTLET CHANNEL

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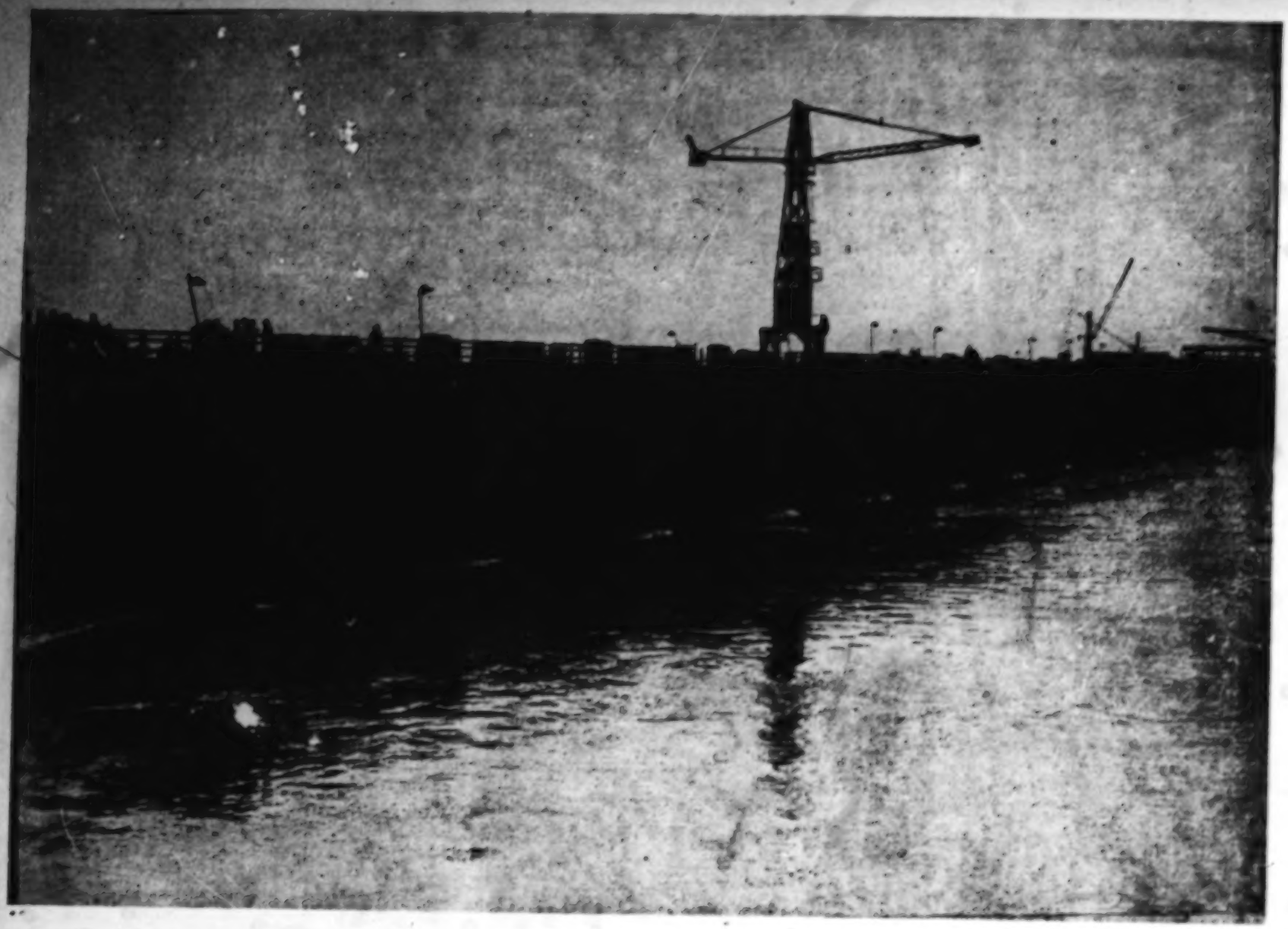

Thirthar Regulator

Depression. The Ishaqi Canal intake regulator is included in the structure of the barrage.

The highest discharge of the Tigirs River near Samarra was estimated at about 12,000 cumecs. It will therefore be possible by the Tharthar Project to control the flood of the river thus, the highest discharge downstream the barrage will not exceed 7,000 cumecs in any circumstance.

The sub - contract for the supply of the sluice - gates and relative parts was awarded to Ransomes and Rapier. The programme for supply of the gates was identical to the original construction programme.

Hydro-Electric Power Generation Station:

The plans of the Samarra Barrage include provisions for electric power generation. The designs in this respect were entrusted to Preece, Cardew & Ryder of England. The power to be generated is estimated at 105,000 Kilowatt.

Water Storage Projects.

BEKHME RESERVOIR PROJECT:

In May 1952, the Board entrusted the Harza Engineering Company with the task of studying the Bekhme Project on the Greater Zab. This project will be utilized for reducing the pressure of flood - waters and for the generation of electric power, besides serving as a reservoir for supplying the Tigris River with water during the Summer season.

The consultants conducted investigations to determine a suitable site. The choice of the geological expert of Harza Engineering Company fell on the upper site at the entrance to Bekhme Gorge, because of the presence there of formation containing some of the best limestone in Iraq which is resistants to infiltration or dissolution in water.

This reservoir is situated in Erbil Liwa in northern - eastern Iraq in the gorge through which the greater Zab passes, and within the chain of Peer - dagh mountains. It could be reached through Shaqlawa - Rayat Road. The Development Board commenced work for opening a road beginnng from Aqra through Zinta Gorge, and thereafter to the damsite. This road will be used for transporting the machinery, equipment, and construction materials to the site.

The Company submitted its initial report and proposals and selected a " heavy - buttress " type of dam, as being most suitable for this location, with a final

Bekhme Reservoir

height of 165 meters. This will make it the highest dam of its kind in the world.

In view of the recommndation of the Consulting Engineers, it was decided to prepare the designs for carrying the construction of the dam in two stages:

Stage 1 : The dam will be constructed to a height of 115 meters or 500 meters above sea - level, with a storage capacity of 3 milliard cubic meters of water.

Stage II : The dam will be heightened upto 550 meters above sea - level. Its final height will them become 165 meters with a storage capacity of 8.3 millard cubic meters. The water will inundate an area of 140 square kilometers. The operation of the dam however, will be possible in its first stage, while work on the second stage is being carried out.

The electric power that - could be generated is estimated at 600,000 Kw. 2,700,000 KW/hr.

The Board purchased four drilling machines for the purpose of carrying out additional boring in the damsite. The tender for this additional work was advertised and the contract was awarded to the Associated Drilling & Supply Company. The boring work was performed under the supervision of the Consultants.

The huge quantities of storage water will irrigate about 6.6 million mesharas of land cultivated at present according to fallow system. About 25 million mesharas of " new " lands in the Tigris River basin, particularly within the Nehrawan and Gharraf Projects will also be sultivated on a " dense " system.

DOKAN PROJECT:

In May, 1951, the Development Board appointed Binnie, Deacon & Gourley, to act in the capacity of Consulting Engineers for the Dokan Reservoir Project. Having completed its studies and investigations the Company prepared preliminary designs for a concrete arch - dam, to be constructed on the proposed site mentioned in the Consultants' studies,

Dokan Reservoir

The choice of the Consulting Geologist, Dr. Hitchens, fell on the Dokan Gorge, as being the most suitable of four sites chosen for this purpose on the Lesser Zab. The Consulting Engineers supported Dr. Hitchens in his choice of this site. Their support, however, was made after boring explorations at the site were carried out under their supervision by Soil Mechanics Ltd. This firm prepared a report on the results of boring work and investigations in which it approved of the suitability of the site from the geological point of view. This statement convinced the Consulting Engineers of the possibility of constructing the dam across the Dokan Gorge.

Because of the difficulties in the design of an arch-dam & the great responsibilities involved in such a huge project, the Board approved the suggestion of the Consultants, to check the results of the designs on the basis of the most modern calculating methods. The consultants were also authorized to carry out hydraulic model tests for examining the bell - mouth spillway and the gated spillway.

As a further precautionary measure the Board referred the plans to a body of experts of world repute in the field of reservoirs and dams in order to make sure of the accuracy of the plans, and their suitability to this site. This consultative commission was formed from three experts: Sir William Halerow of Britain, Mr. Harper of U. S. A. and Mr. Coyne of France. The three advisory members came to Iraq and studied the designs, and the site, and submitted their recommendations in this respect. Having been approved by the Board, the Consultants were asked to amend their designs in conformity with the advisers recommendations.

At the suggestion of this advisory commssion, & in order to restrict probable water losses from the reservoir by leakage through certain cracks in the lime - rock in front of the dam, it was decided to fill the cracks with cement grout; likewise, the foundation of the dam will be excavated and filled with cement grout so as to create a wall to prevent seepage of

Dokan Reservoir

water from the bottom of the dam through the limestone cracks.

On this basis, the consultants prepared the final designs of the dam and its supplements. The tender was advertised on May 2nd, 1953 and eleven bids were received. The contract was awarded to Dumez-Ballot at a cost of ID. 8,817,131/287. The contract consists of the following works:

(1) Construction of the archdam to a height of 116 metres and a length of 360 meters and the installation of five steel - lined, outlets each 3.65 meters in diameter, for the passage of water to generate electric power. At this new height the storage capacity of the reservoir will be 6.8 billion cubic meters.

(2) Construction of a tunnel, 12.5 meters diameter on the left bank of the river to divert the course of the river during the construction of the dam. This tunnel will be used later as a spillway to carry away the excess quantities of water. The contract also provides for the construction of a second tunned 11 meters diameter for draining the flood -water. This tunnel will be equipped with sluice - gates at its head.

There are also the following secondary works connected to this project; the respective contracts have either been or will be awarded very soon:

(a) Gates and safety valves.

(b) Steel linings of tunnels and conduits.

(c) Emergency gates and cranes.

(d) Grouting.

Hydraulics:

It is relevant to mention here some hydraulic data concerning the Lesser Zab:

Area of the river basin	11,690 sq. Km.
Highest discharge (on 25/3/1954)	3,660 cumecs.
Average discharge	203 cumecs.
Lowest discharge of the river	25 cumecs.

The recording of the Lesser Zab discharges at Altun Kupri, south of Dokan, started on 1930. Before this period, discharges at this point were recorded during intervals since 1925. The discharge of the river in the flood season near Dokan equals 80 % of the discharge at the same period near Altun Kupri.

It is worthy of mention that the Dokan Project will irrigate an area covering about 1,300,000 mesharas.

DERBEND - I - KHAN RESERVOIR:

The Derbend - i - Khan Project is situated in the north - eastern district of Iraq between Kirkuk and Diyala Liwas, where the Diyala River cross - cuts in the north - eastern & south - eastern direction a deep gorge called Derbend - i - Khan, cutting in the meantime the mountainous chain of Paranindagh. It is very difficult to reach this site by the only rough road from Halabja, which extends over a distance of 28 Kilometers. Transport means cannot reach the site during the rain - season. A road was opened of late for motor transport, 130 Km. in length, passing through Jalawla, where the nearest railway station to the damsite lies. This road, which is now being used, rans alongside the Diyala River are the distance to the reservoir site.

The expert geologist Dr. Hitchins carried out in the late months of 1946 some preliminary investigations in Derbend - i - Khan Gorge, as a result of which his choice fell on two sites as being suitable for the erection of the dam, the first, in the North, at the entrance to the Gorge & the second

in the South, at the tails of Gorge.

In accordance with these investigations the Board requested the Consulting Engineers, Coode and Partners to carry out the necessary investigations & boring, which they actually did, and further, prepared designs, drawings and specifications for a stone - filled type of dam as being suitable to the nature of the selected site with the erection of a frontal reinforced concrete protective barrier 89 meters high.

It was later found that the capacity of the reservoir of 1.37 milliards cu. m. will not meet the irrigation requirements for the lands falling within the Diyala River basin. It was also found that this type of dam is not so desirable in view of the possible cracking of the stone in the frontal protective barrier which may be caused by the settling of the stone, which may involve considerable maintence.

For these reasons, the Board entrusted Harza Engineering Company with the task of studying and investigating a third site in between the two proposed sites, for the erection of the dam.

The firm of Dr. Hochne carried out under the supervision of Harza Engineering Company, boring work at the proposed third site & consequently the construction there of a rock - filled type of dam was found possible. The dam could be constructed to a height of 140 meters and a length of 435 meters. It appeared from aero - maps prepared by Hunting Aero - Surveys, who surveyed the damsite from the air, that the storage capacity of the reservoir will be about 3.7 milliard cubic meters.

After completing the first stage of its work Harza Engineering Company was entrusted by the Board with the task involved in the second stage that is, choosing the type of dam suitable to the site and preparing the necessary report thereon, also to prepare designs, drawings and specifications for the purpose of advertising the tender. On the Consultants recommendations the Board approved recently that the dam will be of the rockfill type.

The Consultants also prepared drawings and specifications concerning the construction of a diversion tunnel; this work was awarded to the French firm Sainrapt et Brice for ID. 403,947, and is progressing ever since. The Board also awarded the construction of the dam to the contracting group of J. A. Jones. C. H. Tompkins. Tecon Corp & Beton - und Monierbau for ID. 11,474,258.

Hydraulics:

We give below some hydrological data of the Diyala River:

Area of the River basin.	17,750 sq. Km.
Highest on (25/3/1954).	4,000 cumecs.
Average discharge.	164 cumecs.

It appeared from the discharge recordings that the discharge of the river at the Derbend - i - Khan damsite reaches about 71 % of its discharge near Diyala Weir. The discharges during flood seasons were studied along with the recordings of up - to - date discharge measures.

ESKI MOSUL PROJECT:

It was found necessary to erect a dam on the Upper Tigris north of Mosul, for the control of the river floods at its upper reaches, and for the generation of electric power and storage of water irrigation. The Board approved that Mounsell, Posford & Pavry should conduct investigations and choose a damsite north of Mosul. Messrs. George Wimpey, under the supervision of the Consultants, made explorations at several positions to select and ascertain the most suitable site for the erection of

the dam in view of the presence of gypsum deposits which might cause loss of storage water.

The report on the results of the studies and explorations conducted by the Company was received. It states that the erection of a huge dam at the selected site 12 kilometers north of Eski Mosul is feasible from the practical and economic points of view. Moreover, this site is the most suitable between Mosul and the Turkish Frontier for the construction of the reservoir. Construction of the resevoir at this site would allow a storage capacity of 8 milliard cubic meters of water affecting water-level of the Tigris outside the Iraqi borders.

A rock or earth fill type of dam was suggested. The cost was estimated at about ID. 16,000,000/—. As there will be some geological difficulties owing to the presence of gypsum in the site a geologist specialised in the construction of rock-fill and earth-fill dams was employed to examine the report prepared by the Company which conducted investigations and carried out excavations in that district, and to inspect the proposed site. The specialist performed his task and submitted a report.

In order to determine the type of the dam and to carry out geological studies and prepare plans and specifications, the Board asked six engineering companies, of world wide experience in the field of dam erection, to submit offers for the consulting work. Offers were received and are being considered by the Board.

Guided by studies to be made by the Consulting Engineers yet to be selected, the Board will decide on the priority of either Eski Mosul or Bekhme Projects, which will be used for flood control and storage of water for the reclamation and irrigation of large areas of land as well as for generation of power.

DAM NORTH OF HIT - AT KHAN - EL - BAGHDADI OR RAWA:

It appears from studies already made that the Habbaniyah Lake alone is not capable of storing sufficient quantities of water for the exploitation of lands lying along the Euphrates neither it could be used for complete flood control. As the quantities of water-flow in this river depend on the extent of consumption by the Syrian farmers, it was found necessary to study the possibility of locating sites for storing water within the Iraqi border.

The topographic conditions at Rawa and Khan el-Baghdadi indicate a possibility of constructing dams at either site. The Board is intending to carry out studies of the project.

BATMA BARRAGE ON THE LESSER ZAB:

This barrage is considered as part of the Dokhan Project as it will be constructed on the Lesser Zab to raise the water supplied by the Dokan Reservoir for the irrigation of Makhmour lands and the expansion of Haweeja Project. It will also divert the surplus water through a feeder to be excavated later, to the Udhaim River. This work includes the construction of a regulator at the right bank, at the head of Makhmour Canal, the expansion of the Haweeja Regulator on the left Bank, and a regulator for the Udhaim Feeder Canal.

The Board entrusted Binnie, Deacon & Gourley, with the task of studying this work. Preliminary research and boring were carried out at the chosen site to ensure the safety of the foundations. Experimental tests were made at the Hydraulic Laboratory at Hindiyah Barrage.

With this data in hand, the consultants

DEVELOPMENT BOARD

ADHAIM SCHEME

GENERAL MAP

Scale

10 Km 0 10 20 30 40 50 Km

ERBIL

DOKAN DAMSITE

LESSER ZAB

Batme Barrage

Makhmur Area

Hawija Area

KIRKUK

DERBENDI KHAN DAMSITE

DIYALAH RIVER

JABAL HAMRIN

Baiji

I.S.R. Line

TIGRIS RIVER

Band El Audhaim Barrage

Khanaqin

Khalis

BAQUBA

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Prepared By. Izaki Joussif

prepared preliminary designs of the barrage but owing to lack of sufficient information about the area of land to be included within the irrigation scope of the Haweeja and Makhmour Projects and the relation of this barrage to the Dokan Dam Project, its design and planning being contingent on the volume of water that Dokan Reservoir will supply, the Consulting Engineers were instructed to postpone its consideration until such information is available provided that its execution is timed to fit in with the completion of Dokan Project.

AL - UDHAIM BARRAGE:

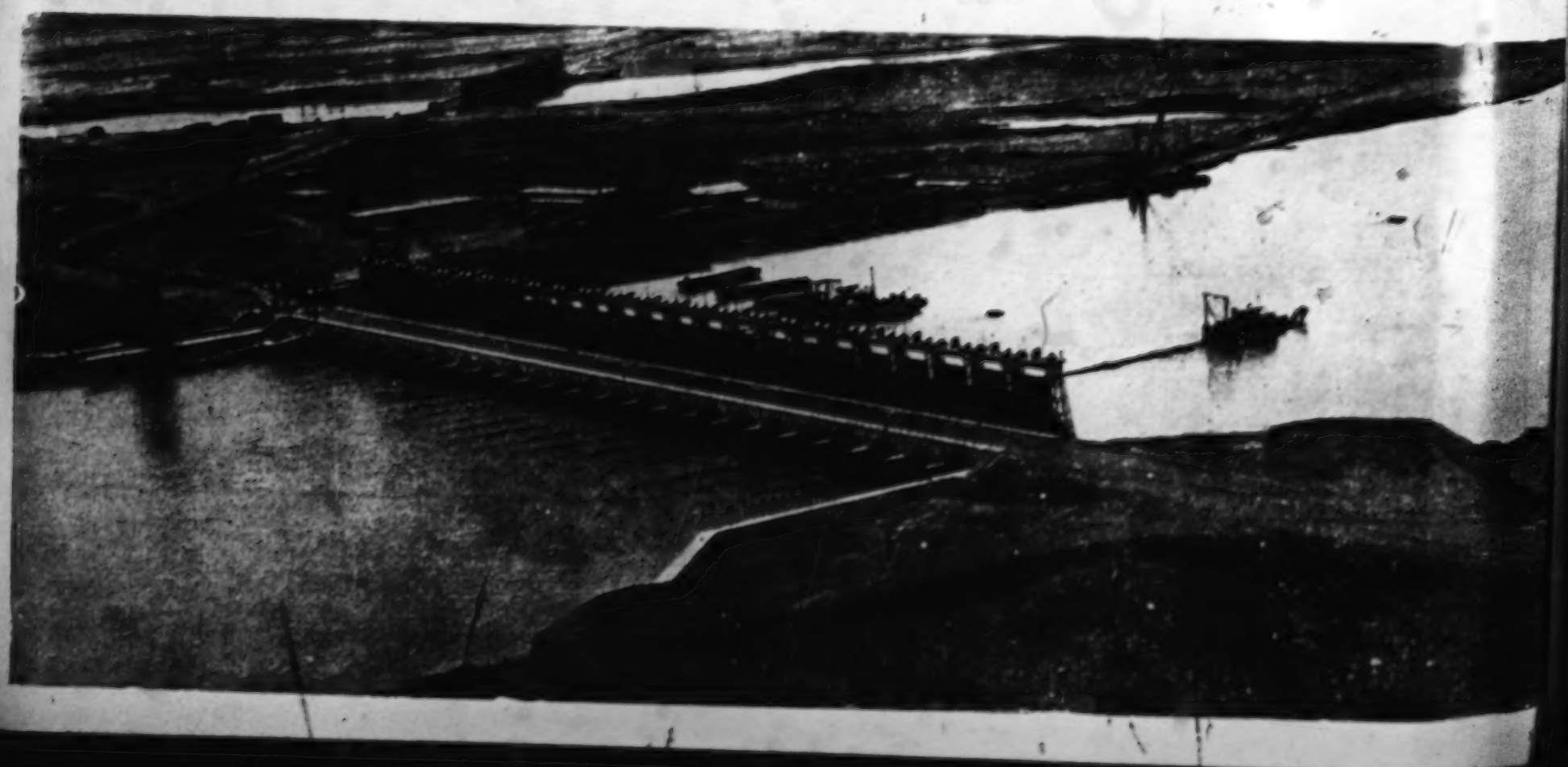
It was decided to construct a barrage on Al - Udhaim River to raise the level of the water supplied from Dokan Reservoir to Al - Udhaim through the feeder channel, for the irrigation of land situated on the right bank of Al - Udhaim (total area estimated at 214,000 mesharas) and Al - Gharaf lands situated on the left bank of Al-Udhaim (total area estimated at 662,000 mesharas). The Board entrusted the Consulting Engineers, Binnie, Deacon and Gourley with the necessary studies and researches; they have already submitted the result of their initial work in connection with the following three sites:-

1. Damir Kapu, as dam and reservoir.
2. Albu Awad, as a barrage.
3. The gorge near Derbend-i-Udhaim.

They also carried out geological studies of the damsite at Damir Kapu, while Messrs. George Wimpey, under their supervision, conducted the necessary drillings. The Consultants are continuing their studies and are expected to submit their report shortly. It is believed that the site at Damir Kapu is suitable for the erection of a dam to a height of 60 meters with a storage capacity of 3 milliard cubic meters, and capable of generating electric power estimated at 138,000 Kw.

The Directorate - General of Survey, surveyed during last year, the Ghurafa district together with the lands situated at the right bank of Al - Udhaim River to ascertain the areas which could be irrigated and determine its topography. The Directorate is now preparing the relative topographic maps.

Ramadi Barrage and Warrar Regulator



Irrigation Projects.

The Board entrusted to the Consulting Engineers, Knappen, Tippetts, Abbett and Mc Carthy, the task of studying the necessary means for regulating and the methods of benefiting from the waters of the Tigris and Euphrates Rivers and their branches. The consultants carried out the studies and investigations required and submitted their final report in October 1952 which contained their recommendations concerning the irrigation projects and their locations, together with a general soil classification of Iraq, with their opinion as to suitability, irrigation, cultivation potentialities and the ways & means of land reclamation The Consultants recommended the adoption of dence cultivation and rotation farming instead of the fallow system now in practice.

EUPHRATES RIVER PROJECT:

(1) Remodelling of the Tails of the Euphrates River at Suq - el Shuyoukh :

The Board entrusted to Knappen, Tippetts, Abbetts and Mc Carthy, to remodel the tails of the Euphrates River at Suq - el - Shuyoukh. The firm completed the survey and investigation work and prepared drawings for the construction of five regulators namely, Um Nakhla, Huffar, Bani Said, Garmat Hassan and Akaika. The contract for this work was awarded in February, 1954, to the Contracting & Trading Co. at a cost of ID. 647,410/-. This amount includes cost of supplying sluic - gates for the regulators. The work is expected to be completed in 1956. It should be mentioned that the construction of these regulators will help to a great extent the control of flood-waters of the river at the Suq-el-Shuyoukh sector. In this manner, it will be possible to benefit from the water for cultivation.

(2) Enlarging & Remodeling of Shatt el - Hillah and its Main Branches :

The Board also requested Knappen, Tippetts, Abbetts and Mc Carthy to study the possibility of expanding & remodelling Shatt el - Hillah, and the reclamation of the Dagharra Canal. They were instructed to prepare designs and drawings for the expansion and desilting of the canal. Consequently, the Engineers carried out studies and investigations and submitted a report in which they advised that the Hillah Canal expansion project may include new areas covering 1,795,000 mesharas of Miri Sirf lands. This area may be divided into small holdings where intense rotation forming could be followed and increase the crop output rather than continue with the fallow system presently in practice in lands irrigated by gravity covering one million mesharas.

The Board approved the expansion of the Hillah Canal from its head downstream to Babil together with the expansion of the latter to provide water for 400,000 mesharas of Miri lands. This work includes the construction of the necessary head structures, regulators and drains.

The Consulting Engineers are completing the relative specifications and designs, and tenders will be called shortly. The work includes the following:

(a) Cross Regulator on the Hillah Canal with navigation lock and mobile bridge to be erected over the lock.

(b) Inlet regulator on Babíl.

(c) Cross regulator on Babil Canal at Km. 9.200.

(d) Cross regulator on Babil Canal at Kilometer 18.250.

(e) Earth embankments.

The Board also entrusted the firm of Knappen, Tippetts, Abbett and Mc Carthy with the task of land classification of an area of over one million mesharas at the tails of the Hillah Canal. The study is now completed and the report being prepared.

(3) Remodelling of the Kufa and Shaimiyah Canals & stopping of Naggarat (Soil Erosion) :

The Board approved the allocation of ID. 37.101 for the construction of (11) regulators on both sides of the Mish - Khab and ID. 33,000/- for the construction of bunds on its banks with a cross regulator, a lateral regulator and a navigation lock. The Directorate - General of Irrigation was entrusted with the execution of this work on behalf of the Board. The construction of the regulator at the tails of Shatt el-Shamiyah has been completed.

(4) The Greater Musseyeb Project :

Designs, specifications and estimates have been completed and the project will cover new lands covering 246,000 mesharas over and above the 57,000 mesharas now under irrigation.

In order to accelarate the preparation of designs and specifications so as to ensure the execution of the work speedly and regularly, the work has been divided into fifteen sections Contracts concerning most of them were awarded but a tenders concerning structures at the canals were called only:

1. Excavations of Main Canals: The work was awarded on 2nd February 1953 to the Arab Contracting & Trading Company at a cost of ID. 273,600/-. Work was completed on 27/2/1955.

2. Construction of Main Regulators: The work was awarded on 15/4/1953 to the Middle East Engineering & Construction Co. Ltd., at a cost of ID. 64,398/780 and was completed on 3/5/1955.

3. Construction of Two Cross Regulators: This work was awarded on 11/11/1953 to the Middle East Engineering and Construction Co. Ltd., at a cost of ID. 35,444/400. Work was completed on 28/6/1955.

4. Excavation of the General Drain and the Main Northern and Southern Drains: The contract was awarded on 14/4/1954 to Societe Annoymo Ossude (French) at a cost of ID. 759,867/-. The work is to be completd on 13/10/1956.

5. Canal structures awarded on May 26, 1954 to Freed al-Ahmar and Khente Tajerian for ID. 69,816/-.

6. Awardad to Micheal Dumet for ID. 207,200/-.

7. Musayeb Branch Drain: awarded on the 25/12/1954 to the Pan Arabain Engineering Co.

8. Pumping Station for Mussayeb Drain: awarded on 22/10/1955 to Faiha Trading Co.

9. (Excavation of lateral canals: awarded on February 27,1955 to Micheal Dum for ID. 111,000/-.

10. (Supply of logs): awarded to Nazih at-Suwaidi for ID. 11,350/-.

11. Enlargment of Main Canal, and parallel structures: awarded to Central Iraq Trading Co. for ID. 81,866/-. The work to be completed in 12 months.

12. Supply of Precast Concrete pipes and cement: awarded on 30/7/1955 to the Construction Material Co. for ID. 49,344/920.

The Materials to be supplied in 7 months.

13. (Construction of Lateral Canals: awarded on 30/7/1955 to S. T. Ossude for ID. 185,660/150. The Work to be finished in 24 months.

The Ministry of Agriculture has been

authorized to execute this project including all its sections, on behalf of the Minstry of Development, and under the Directorate - General of Irrigation.

TIGRIS RIVER PROJECTS:

These water which will be stored in Bekhme reservoir on the Greater Zab and in Eski Mosul Reservoir on the Tigris River, shall be used for organising agriculture in the Tigris River basin and its tributaries as follows:-

(1) Reclamation of Nehrawan Lands :

These lands are situated in eastern bank of the Tigris River south of the Diyala River, The area involved is estimated at 1,117000 mesharas. It will be irrigated by constructing a barrage across the Tigris River at Dokhala, to raise & divert the river - water through a feeder to Diyala River, at a point north of the proposed Khan Beni Sa'ad Barrage, which will raise and divert the water to the Nehrawan Basin.

The Consulting Engineers Coode and Partners carried out investigations in connection relative will comprise with Khan Beni Saad Barrage, and prepared the designs, drawings and estimates. The barrage consists of 24 vents.

However, the Board decided to postpone this project until such time as the studies and soil classification of the Nehrawan lands have been completed by the Consultants. Binnie, Deacon and Gourley.

(2) Expanding and remodelling of the Gharraf Canal :

The Board entrusted the study and remodelling of lands in this district to Knappen. Tippetts, Abbett and Mc Carthy. The project will include remodeling of the presently irrigated areas which cover 2,350.000 mesharas and the addition of new area estimated at 600.000 mesharas of Miri Sirf Lands. The study of the Consulting Engineers includes the regulation of water distribution, drains, and classification of soil, as well as preparation of designs, drawings, and estimates for all the installation, excavation of canals and drains covered by the project. The Board received the report of the Consulting Engineers who recommended construction of the followng:

(a) The Western Outfall.
(b) The Eastern Outfall.
(c) Four Regulators on the Gharraf with bunds and lateral gates.
(d) Construction of the Dujaila Outfall.
(e) Excavation of a canal for the irrigation of new Miri Sirf Lands, situated at Jezirat Sayid Ahmed - el - Rifa'i together with relative installations.
(f) Erection of seven regulators on the Bad'a Canal.

(3) Study of the Northern District :

The Board entrusted the Irrigation Directorate to study the Northern districts and indicate the cultivable areas, the suitable system of irrigation, methods of development and exploitation and establishment of minor schemes for setting the inhabitants of villages and other lands which will be inundated as a result of the construction of reservoirs. The report has been received & the Board entrusted the Irrigation Directorate with the task of preparing the designs of the Sangasar Project. Kuljian Corporation was entrusted with the study of the Quwair - Suwarish, Khazir - Gomel, and Zakqo areas.

(4) Basrah Lands :

The Board entrusted the Consulting Engineers, Knappen, Tippetts Abbett and McCarthy with the task of studying Basrah Liwa and the ways and means of improving its irrigation schemes. They were asked to prepare their initial reports

on this subject so that the Board may know how floods in Shatt - El - Arab and Horel - Hammar could be controlled and the arable lands on the banks of Shatt-El-Arab could be revived. They were also asked to estimate the other agricultural potentialities in the Liwa. The Consulting Engineers carried out the necessary surveys, soil classification and other investigations. They carried out the work and submitted their report, which is under consideration by the Board.

THE LESSER ZAB & ADHAIM RIVERS' BASIN:

We have previously mentioned that the Board decided to make use of the Lesser Zab waters which will be stored in Dokan for irrigating the Lesser Zab and Adhaim basins by constructing the Battmah Barrage on the Lesser Zab River to increase the river's discharge at Hawijah Canal and to irrigate Makhmoor on the right bank. The Hawijah Canal is heing enlarged and waters shall be diverted from the Lesser Zab to the Adhaim River through a feeder channel connected to Zugaitoon Valley, north of Hamreen Mountain. A barrage shall be constructed on the Adhaim River to raise the water level and two canals will be excavated on both sides of the river to irrigates the Ghurfa land.

Lands which will make use of this project are:

Makhmour District	162,000 Mesharas
Hawija District	253,000 Mesharas
Adhaim Rigth Bank	214,000 Mesharas
Adhaim Left Bank (Ghurfa)	663,000 Mesharas
Total	1,291,000 Mesharas

The Consulting Engineers, Bennie, Deacon and Gourley conducted preliminar studies in Makhmour District. They completed the design of Batmah Barrage on the Lesser Zab after conducting experimental tests in the hydraulic Laboratory at the Hindiyah Barrage. The same firm is now studying the entire project of irrigation of the Adhaim Valley.

DIYALA RIVER BASIN:

The Board decided to make use of the Diyala River waters which shall be in Derbend-i-Khan Reservoir, for irrigating the Diyala Basin by enlarging and organising the canal system there as well as by excavating several canals for irrigating the following fertile lands:-

Diyala Land (Left Bank) area about	980,000 Mesharas.
Diyala Land (Right Bank) area about	560,000 Mesharas.

The Board is now considering the selection of a Consulting Engineering firm to carry out this work.

DRAINAGE PROJECTS.

Shortage of rain, high temperature, perennial irrigation and the rise of subterranean led to concentration of salt in the soil of the Rafidain Delta. In certain districts, the concentration of salt has been so intensive that the cultivation of land is impossible unless salinity is washed out and the water drained, into drains. Such drains will make the control of subterraneanand surplus water possible and the salinty will eventually be reduced and the lands will be exploited to the maximum extent.

The Board undertook to combat salinity and adopted the principle of constructing drains in such irrigated lands where soil analysis show a demand for same. In the lands where new projects will be introduced, the excavation of drains will proceed side by side with the excavation of canals in accordance with the programme of the Development Board, as follows:

(1) The Dujaila Drain:

The Board commenced with the

construction of this drain for reviving and draining an area of 25,000 mesharas as a first step and as remodel scheme in the Dujailla district. Excavations have been completed and the necessary pumping plants erected and are now in use. The overall cost amounted to about ID. 40,000/-.

(2) The Saqlawiyah Drain:

It will be possible, through this project, to drain an area of 166,000 mesharas in the Saqlawiyah and Abu Gharaib districts. The Board allocated ID. 60,900 for this purpose. Drawings and tender documents were prepared and a contract for the excavation of the drain with its branches has been awarded on 1: th. December, 1953, to the Central Iraq T ading Compony Ltd., at ID. 281,908/- the work to be completed on 20th, July 1957. The Contract for the supply of the p imping plant was awarded to the Dutch Farm, Stock. The Contract for the con- s ruction of the pumping plant building was awarded to Edward Rassam.

The D. G. of Irrigation is supervising the execution of the excavation of the drain and its branches. This Department has also been entrusted to construct 3 Kilometers in length of the lined canal, on behalf of the Board. The whole project was completed at the beginning of 1956.

(3) Tuwairij Drain:

About 41,300 mesharas at Hindiyah Qadha will benefit from this project for which ID. 61,000 has been allocated. The Contract for the supply and erection of pumping plants was awarded to Stephen Lynch and Co. Ltd. Tenders for the construction of the pumping plant building were called and the earth - work have been entrusted to the Directorate - General of Irrigation. It is expected that this project will be completed at the beginning of 1957.

(4) Mussayeb Drains:

Field studies and soil analysis of the lands falling within the Greater Mussayeb Project and Babylon Canal for setting-up a drainage system have been completed. About 741,000 mesharas will be drained by system. The contract for the excavation of the Mussayeb and Babylon drains have been awarded to S. A., Ossude on 31/3/1954. Work is expected to be completed within two years.

(5) Baquba Drains:

The Directorate - General of Irrigation prepared designs, drawings and estimates for the Baquba Drains which will be erected in the Khoraisan Canal area at the left bank of the Diyala River, for draining about 11,800 mesharas. The Board allocated ID. 40,000/- for this project and authorised the Ministry of Agriculture to spend it. The Directorat - General of Irrigation started with the execution of this work on behalf of the Development Board.

(6) Hawijah Drains:

Studies, investigations and designs for deepening and expanding the existing Hawijah drains have been completed. The execution of this work started.

(7) Washash Drain:

The Board allocated ID. 20,000/- for the construction of the Washash drain, Studies investigations and designs have been prepared, The Washash drain will be used to carry away the stagnant waters flowing to the Khir Canal from the adjacent gardens and farms.

(8) Shamiya Drain:

The Directorate - General of Irrigation excavated the Eastern Drain between Kilometer 1 and 6, on behalf of the Board. Designs estimates and tender documents for the excavation of this drain to kilometer 64 were prepared by this Department and tenders were invited on 14th, March 1954.

CHAPTER — I

VOTE — II

FLOOD CONTROL, IRRIGATION AND DRAINAGE PROJECTS.

ALL FIGURES IN MILLIONS OF DINARS.

Article.	Particulars.	Total Estimated sum	Cost up to 31/3/956	Allocation 1956-1957	Allocation 1957-1958	Allocation 1958-1959	Allocation 1959-1960	Allocation 1960-1691	5 yeares Total Cost	Complementary sum
1.	EUPHRATES RIVER									
A.	Irrigation Reservoirs	2,9	1,4	1,0	0,5	–	–	–	1,5	–
B.	Hillah Canal	25,0	0,17	2,0	2,0	2,0	2,0	2,0	10,0	14,83
C.	Other Canals	6,75	1,75	1,0	1,0	1,0	1,0	1,0	5,0	–
D.	Control Structures	5,25	0,25	1,0	1,0	1,0	1,0	1,0	5,0	–
TOTAL OF ARTICLE (1)		39,90	3,57	5,0	4,5	4,0	4,0	4,0	21,5	14,83
2.	TIGRIS RIVER BASIN (The Lesser Zab and Al-Adhaim Rivers)									
A.	Dokan Dam	13,0	2,7	5,5	4,3	0,5	–	–	10,3	–
B.	Batma Barrage	2,0	–	0,25	1,0	0,75	–	–	2,0	–
C.	Al-Adhaim Barrage	1,5	–	0,5	0,7	0,3	–	–	1,5	–
D.	Lands Reclamation	20,00	0,195	0,4	1,0	1,5	1,5	1,5	5,9	13,905
TOTAL OF ARTICLE (2)		36,5	2,895	6,65	7,0	3,05	1,5	1,5	19,7	13,905
3	THARTHAR PROPECT The Dam	16,5	12,1	3,5	0,9	–	–	–	4,4	–
TOTAL OF ARTICLE (3)		16,5	12,1	3,5	0,9	–	–	–	4,4	–
4.	DERBEND KHAN DAM	17,0	0,5	4,0	5,0	5,0	2,5	–	16,5	–
TOTAL OF ARTICLE (4)		17,0	0,5	4,0	5,0	5,0	2,5	–	16,5	–
5.	AL-GHARRAF	12,0	–	0,5	1,5	2,0	2,0	2,0	8,0	4,0
TOTAL OF ARTICLE (5)		12,0	–	0,5	1,5	2,0	2,0	2,0	8,0	4,0
6.	DRAINAGE									

6. DRAINAGE									
A. Euphrates left bank & Hillah Canal including Rumaitha	29,0	0,825	1,1	1,0	0,65	0,5	0,75	4,0	24,175
B. Lands within the Gharraf Project.	34,0	–	0,2	0,5	1,6	4,0	5,7	12,0	22,0
C. Lands within the Diyala Project	11,0	0,180	0,2	0,5	1,0	1,7	1,6	5,0	5,820
D. Euphrates right bank and Hillah	18,0	0,245	0,3	0,7	1,35	1,3	1,35	5,0	12,755
E. Miscellaneous	8,0	0,450	0,5	0,3	0,4	0,5	0,6	2,3	5,250
TOTAL OF ARTICLE (6)	100.0	1,7	2,3	3,0	5,0	8,0	10,0	28,3	70,0
7. INVESTIGATIONS ETC.									
Basrah Projects	4.0	–	0,25	0,75	0,75	1,25	1,0	4,0	–
Irrigation in north Iraq and water Storage reservoirs, Eski Mosul, Bakhma, Fatha and Thirthar	30,0	–	0,5	1,5	1,5	2,5	5,0	11,0	19,0
Upper Euphrates or other.	30,0	–	0,5	1,0	2,5	3,5	5,0	12,5	17,5
Amarah, Shamiyah and Nasiriyah lands Reclamation	15,0	–	0,4	1,1	2,0	2,5	2,5	8,5	6,5
Air and Ground mapping	0,5	–	0,15	0,15	0,2	–	–	0,5	–
Diyala and middle Tigris	30,0	0,3	0,25	0,5	1,0	1,5	2,5	5,75	23,95
TOTAL OF ARTICLE (7)	109,5	0,3	2,05	5,0	7,95	11,25	16,0	42,25	66,95
GENERAL TOTAL	331,40	21,065	24,00	26,9	27,00	29,25	33,5	140,65	169,685

CHAPTER I.—VOTE II

Flood Control, Irrigation and Drainage Projects.

Proposed Five year Programme 1956-60.

(All figures in Millions of Dinars)

Article.	Item	The Project	1956	1957	1958	1959	1960	Total.
1.		EUPHRATES RIVER						
	A.	Reservoirs	1,0	0,5	—	—	—	1,5
	B.	Hillah Project	2,0	2,0	2,0	2,0	2,0	10,0
	C.	Other Canals	1,0	1,0	1,0	1,0	1,0	5,0
	D.	Control Structures	1,0	1,0	1,0	1,0	1,0	5,0
TOTAL OF ARTICLE (1)			5,0	4,5	4,0	4,0	4,0	21,5
2.		TIGRIS RIVER						
	A.	Dokan Dam	5,5	4,3	0,5	—	—	10,3
	B.	Batma Barrage	0,25	1,0	0,75	—	—	2,0
	C.	Al-Adhaim Barrage	0,5	0,7	0,3	—	—	1,5
	D.	Lands Reclamation	0,4	1,0	1,5	1,5	1,5	5,9
TOTOAL OF ARTICLE(2)			6,65	7,0	3,05	1,5	1,5	19,7
3.		THIRTHAR Project	3,5	0,9	—	—	—	4,4
4.		DERBEND KHAN	4,0	5,0	5,0	2,5	—	16,5
5.		THE GHARRAF PROJECT	0,5	1,5	2,0	2,0	2,0	8,0
6.		DRAINAGE						
	A.	Left bank Hillah	1,1	1,0	0,56	0,5	0,75	4,0
	B.	Gharraf	0,2	0,5	1,6	4,0	5,7	12,0
	C.	Dujaila	0,2	0,5	1,0	1,7	1,6	5,0
	D.	Euphrates-Hillah Right Bank	0,3	0,7	1,35	1,3	1,35	5,0
	E.	Miscellaneous Drains	0,5	0,3	0,4	0,5	0,6	2,3
TOTAL OF ARTICLE (6)			2,3	3,0	5,0	8,0	10,0	28,3
7.		INVESTIGATIONS ETC.						
		Basrah Projects	0,25	0,75	0,75	1,25	1,0	4,0
		Irrigation in the north and water storage reservoirs, Thirthar, Eski Mosul and Bakhma	0,5	1,5	1,5	2,5	5,0	11,0
		Upper Euphrates or other	0,5	1,0	2,5	3,5	5,0	12,5
		Amarah, Shamiyah and Nasiriyah lands Reclamation	0,4	1,1	2,0	2,5	2,5	8,5
		Air and Ground mapping	0,15	0,15	0,2	—	—	0,5
		Diyala and middle Tigris	0,25	0,5	1,0	1,5	2,5	5,75
TOTAL OF ARTICLE (7)			2,05	5,0	7,95	11,25	16,0	42,25
THE GRAND TOTAL CHAPTER I.—VOTE II			24,0	26,9	27,0	29,25	33,5	140,65

44°

46°

48°

36°

34°

E Y

LEGEND

- TOWNS
- DAMS AND BARRAGES
- LAKES
- RIVERS
- PROPOSED CULTIVATION AREA
- EXISTING CULTIVATED AREA
- IRAQ BOUNDARY

G. ZAB R.

BEKHME DAM

AERBIL

BATMA BARRAGE

L. ZAB R.

DOKAN DAM

SULAIMANIYA

KIRKUK

DERBENDI KHAN DAM

AUDHAIM R.

DIYALA R.

DEMIR QAPU BARRAGE

DIYALA WEIR

KHAN BENI SAAD BARRAGE

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ESKI MOSUL DAM

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MOSUL

G. ZAB R.

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DOKAN DAM

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AUDHAIM R.

DIYALA R.

DIYALA WEIR

DEMIR QAPU BARRAGE

SAMARRA BARRAGE

THARTHAR

EUPHRATES R.

RAWA DAM

KHAN BAGHDADI DAM

KHAN BENI SAAD BARRAGE

BAQUBA

RAMADI BARRAGE

RAMADI

BAGHDAD

HINDIYA BARRAGE

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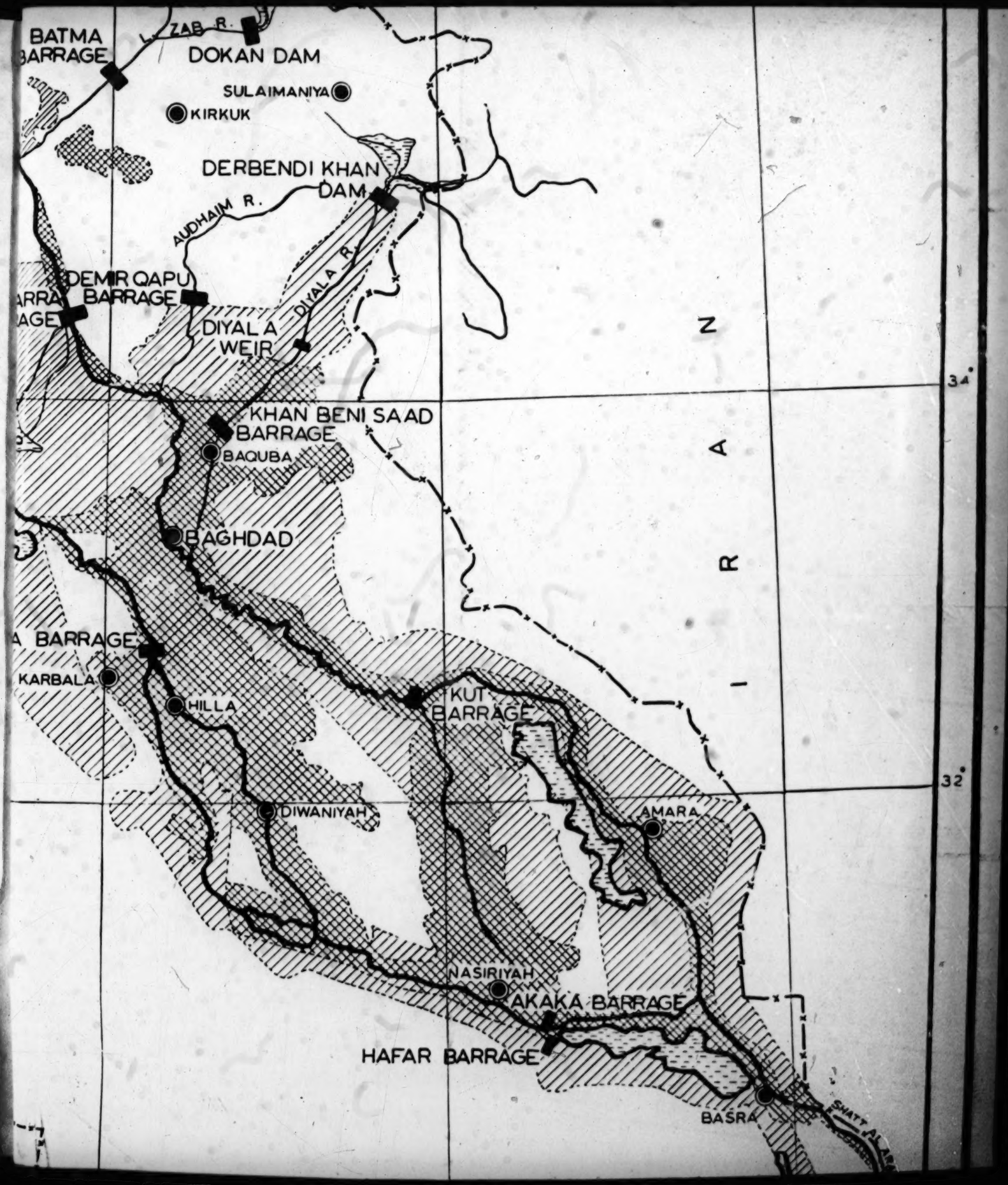
BATMA BARRAGE
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KHAN BENI SAAD BARRAGE
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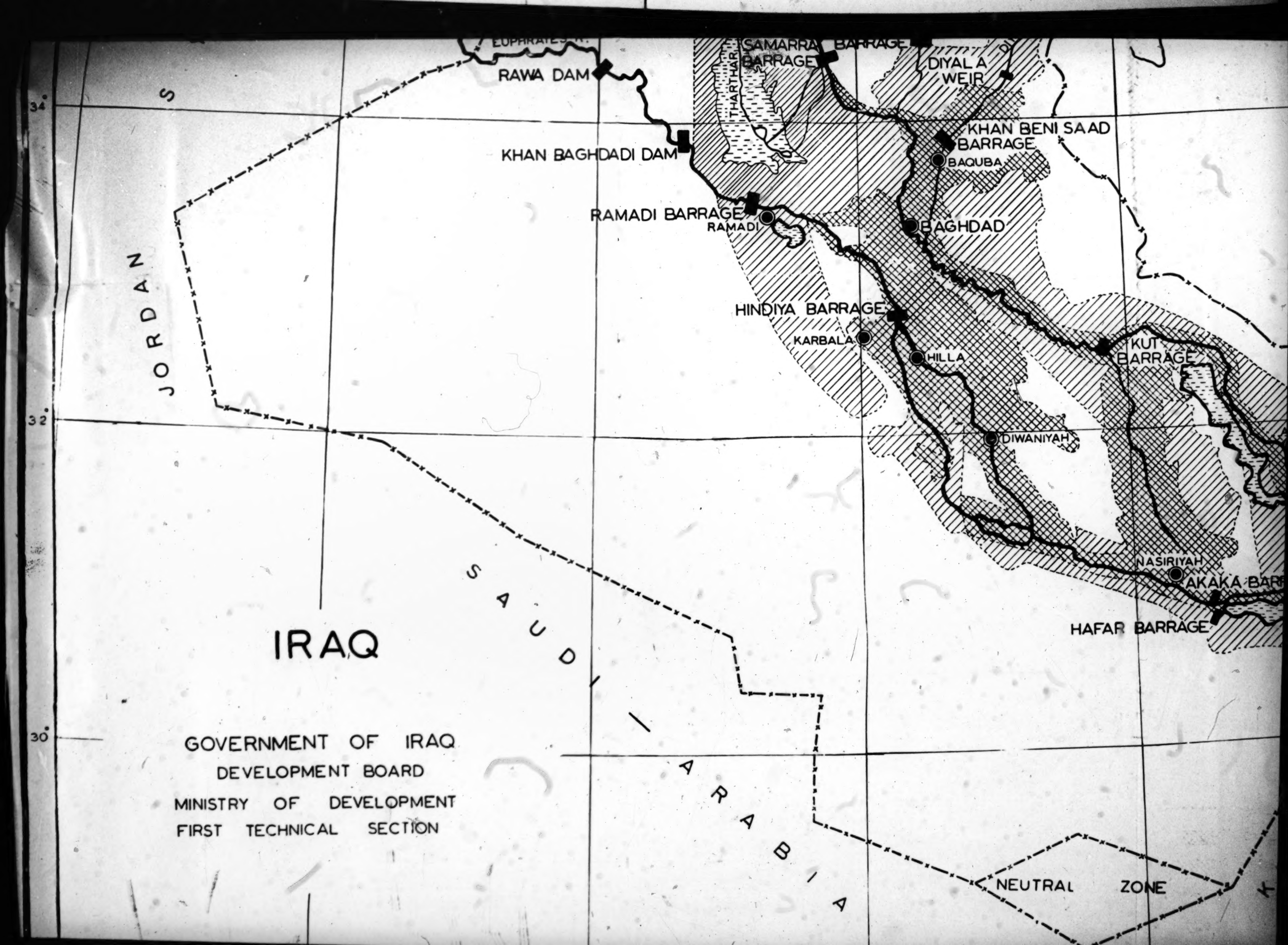
EUPHRATES R.
RAWA DAM
KHAN BAGHDADI DAM
RAMADI BARRAGE
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THARTHAR
SAMARRA BARRAGE
DIYALA WEIR
KHAN BENI SAAD BARRAGE
BAQUBA
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HINDIYA BARRAGE
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HILLA
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NASIRIYAH
AKAKA BARRAGE
HAFAR BARRAGE
JORDAN
SAUDI ARABIA
NEUTRAL ZONE
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GOVERNMENT OF IRAQ
DEVELOPMENT BOARD
MINISTRY OF DEVELOPMENT
FIRST TECHNICAL SECTION

JORDAN

IRAQ

SAUDI ARABIA

HINDIYA BARRAGE

KARBALA

HILLA

KUT BARRAGE

DIWANIYAH

NASIRIYAH

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HAFAR BARRAGE

NEUTRAL ZONE

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28°

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GOVERNMENT OF IRAQ
DEVELOPMENT BOARD
MINISTRY OF DEVELOPMENT
FIRST TECHNICAL SECTION

DRAWN BY VAROUJAN VARTAN

TRACED BY A.SATTAR A JABBAR

HINDIYA BARRAGE
KARBALA
HILLA
KUT BARRAGE
DIWANIYAH
AMARA
NASIRIYAH
AKAKA BARRAGE
HAFAR BARRAGE
BASRA
SHATT AL ARAB
PERSIAN GULF
KUWAIT
NEUTRAL ZONE
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